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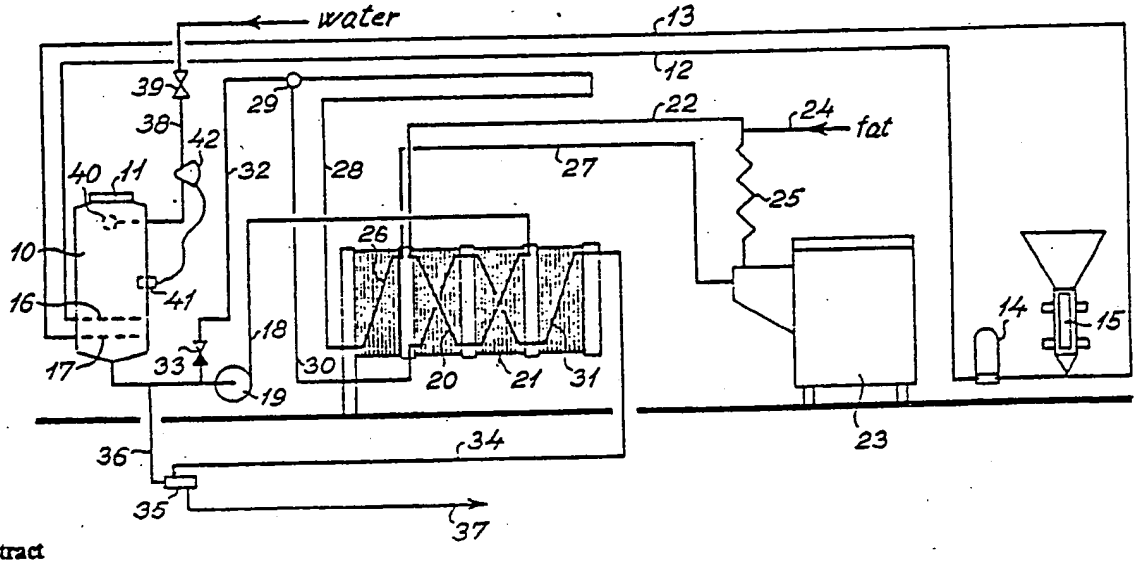

(57) Abstract

In a method and a plant for recombining milk and other milk products water is circulated in a tubing system (12, 13) including a mixing tank (10). Metered amounts of milk powder or another pulverulent or particulate material is supplied to the tubing system by means of a metering apparatus (15) of a type permitting sluicing of metered amounts of pulverulent or particulate material into the tubing system without entraining substantial amounts of air. Due to the substantially reduced foaming liability obtained thereby, the plant may operate continuously with a single mixing tank (10) to which water or another liquid is currently supplied through a supply conduit (38), while liquid mixed with the pulverulent material is discharged through a discharge conduit (18). The mixed liquid may possibly be passed through a pasteurizer (21) and - after the addition of fat through a conduit (24) - to a homogenizer (23), whereafter the recombined milk product is passed to a storage tank through a product discharge conduit (37) in a cooled condition.

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A METHOD AND A PLANT FOR MAKING A LIQUID MILK PRODUCT.

Fresh milk is a relatively perishable product. Therefore, when milk is to be stored for a long period of time or to be transported over long distances, the milk is normally converted into milk powder by spray drying. In areas where no fresh milk is produced, it is desirable to convert the milk powder into a product, which corresponds to fresh milk to the highest possible extent. Therefore, the milk powder or dried milk is exposed to a recombining process, in which the powder is mixed with a suitable amount of water. If it is desired to obtain a full milk product rather than skimmed milk, a suitable amount of fat may also be added.

It is known to perform such a milk recombining process in industrial plants comprising a mixing tank which is inserted in a tubing system including a circulating pump and a metering apparatus for milk powder in the form of an ejector. When a suitable amount of water has been filled into the mixing tank, the circulation pump is started, and milk powder is continuously added to the circulating liquid by means of the ejector or metering apparatus. When milk powder has been supplied to the tubing system in an amount corresponding to the amount of water in the mixing tank and the tubing system, recombined milk which is ready for pasteurizing and possible adding of fat as well as homogenizing, has been produced. However, substantial amounts of air, which give rise to generation of big amounts of foam in the plant or system, will be introduced into the tubing system by the ejector or metering apparatus together with the milk powder. In order to provide sufficient space for the foam created, only part of the volume of the mixing tank may be occupied by water, and, consequently, the mixing tank must be relatively big in relation to the effective capacity of the plant. In the known plants two or

more mixing tanks are normally used, so that recombined milk may be discharged from one of the tanks, while the recombining process is taking place in another. Consequently, the milk product obtains a certain residence time within the tank after the recombining process and before the milk is pumped out of the tank, whereby foam formation may be suppressed to some extent.

However, the recombined milk from the mixing tank is normally passed through a pasteurizing apparatus, and the milk may also pass a fat metering and adding apparatus and a homogenizer. Because the homogenizer is very sensitive to air, in the known plants it is normally necessary to insert an air removing vacuum device in the tubing system upstream of the homogenizer, which gives rise to a substantial increase in cost of the plant. Furthermore, oxidation processes caused by the content of air in the recombined milk may give rise to a deterioration of the taste of the milk.

The present invention provides a method and apparatus of the type described above, in which the foam formation problems described are eliminated or substantially reduced.

The method according to the invention is of the type in which metered amounts of a pulverulent or particulate material is currently added to a liquid which is circulated through a tubing system including a mixing tank, and the method according to the invention is characterized in that said pulverulent or particulate material is sluiced into the tubing system in portions and substantially without entraining air. Such sluicing may, for example, be performed by means of a measuring chamber the ends of which may be sealingly closed by means of dampers, which are operated in such a manner that at least one damper will always be closed, so that the inner of the tubing system will not come into direct communication with the atmosphere. The sluicing of the pulverulent or particulate material is, however, advantageously performed by means of a metering apparatus of the type described in applicant's Danish patent application No. 3162/80 filed on 22nd

July, 1980, which application is hereby incorporated herein by reference. By using the method according to the invention it is possible to substantially reduce the dimensions of the mixing tank, because the major part of the volume of the mixing tank may be occupied by liquid, and the use of air removing devices in the system will be unnecessary.

The substantially airless supply of pulverulent or particulate material makes it possible to perform a continuous recombining process. Thus, according to the invention fresh liquid may continuously be supplied to and liquid milk product may simultaneously be continuously discharged from the tubing system. Such a continuous recombining process makes it possible to obtain an especially high production rate by means of a relatively small plant or system. Furthermore, the continuous process permits an almost instantaneous change in the production, for example by changing the mixing ratio between the pulverulent or particulate product and the liquid. This may, for example, be of importance if it is desired to change a production of recombined full milk for drinking purposes to a production of a milk product to be used by the production of for example yoghurt.

In order to obtain a uniform finished product in a continuous production, it is important that fresh liquid is supplied to the tubing system or the mixing tank at a flow rate corresponding exactly to that at which the milk product is discharged from the system. This may advantageously be obtained thereby that the supply of fresh liquid to the tubing system is controlled by means of a level control device arranged within the mixing tank. Thus, the supply of fresh liquid will at any time be controlled so as to maintain the liquid level in the mixing tank substantially constant, which means that the amount of liquid in the tubing system including the mixing tank remains substantially constant. The liquid is advantageously circulated in the tubing system by means of a pump having a capacity substantially exceeding the capacity of the tubing system. This means that the liquid is circulated in the tubing system and the mixing tank several times, before it is

discharged from the system, whereby a good mixing effect is obtained.

The invention also relates to a plant for use in carrying out the method described above, said plant comprising a tubing system including a mixing tank, a pump for circulating liquid in the tubing system, and a metering apparatus for currently introducing metered amounts of pulverulent or particulate material into the tubing system, and the plant according to the invention is characterized in that the metering apparatus is in the form of a sluicing device adapted to sluice metered amounts of said pulverulent or particulate material into the tubing system without entraining substantial amounts of air.

As explained above, the serious foam formation problems encountered in connection with the known plants, are avoided in connection with the plant according to the invention.

The invention will now be described more in detail with reference to the drawing, which diagrammatically illustrates an embodiment of a milk recombining plant according to the invention.

The plant shown in the drawing comprises a mixing tank 10 in the form of a cylindrical container provided with an air-tightly closing manhole cover 11 at the top thereof. This mixing tank 10 is communicating with a tubing system including a flow conduit 12 and a return conduit 13 which are connected to a centrifugal pump 14 with high capacity. A metering apparatus 15 arranged upstream of the centrifugal pump 14 is of the type described in applicant's above-mentioned Danish patent application No. 3162/80. The flow and return conduits 12 and 13 communicate with annular distributing tubes 16 and 17, respectively, which are arranged coaxially and axially spaced within the lower parts of the tank 10. These distributing tubes 16 and 17 are provided with openings, which are directed axially towards each other.

The bottom of the mixing tank 10 is connected to a product discharge conduit 18 including a centrifugal pump 19 and passing through the preheating section 20 of a conventional plate pasteurizer 21. The preheating section 20 is communicating with a conventional homogenizer 23 through a conduit 22, and a fat metering device (not shown) is connected to the conduit 22 by means of a branched conduit 24. The part of the conduit 22 extending between the branched conduit 24 and the homogenizer 23 contains a conventional static mixer 25 serving to create turbulence and, consequently, a mixing effect in the liquid flowing through the mixer 25. The homogenizer 23 is connected to the heating section 26 of the pasteurizer 21 through a conduit 27, and the discharge opening of the heating section is communicating with a conduit 28, which contains a temperature control by-pass valve 29 having a first position in which liquid flowing from the heating section 26 is passed either through a conduit 30 to the cooling section 31 of the pasteurizer 21, or via a by-pass conduit 32, which is provided with a one-way valve 33, back to the suction side of the centrifugal pump 19 as will be described more in detail below. A conduit 34 interconnects the cooling section 31 of the pasteurizer 21 and a valve 35, which is also communicating with the discharge conduit 18 via a connecting conduit 36. The valve 35 is also communicating with a product discharge conduit 37, which may lead to a storage tank for the finished product.

The milk recombining plant shown in the drawing operates as follows:

Tap water is supplied to the mixing tank 10 through a water supply conduit 38, when a manually operated shut-off valve 39 is opened. The water is introduced into the tank 10 through a shower or spraying device 40 arranged therein. A level sensor 41 controlling a flow regulating valve 42 in the conduit 38 causes the supply of water through the conduit 38 to stop, when the water within the mixing tank 10 has reached a predetermined level. When the desired amount of water has been introduced into the tank 10, the centrifugal pump 14 is started, whereby the water is circulated

through the flow conduit 12, the return conduit 13, and the tank 10. A number of metered amounts of milk powder substantially free of air and corresponding to the desired content of solid matter (apart from fat) in the recombined milk, are introduced into the return conduit 13. Due to the fact that the centrifugal pump 14 has a large capacity, which is preferably in the order of three to six times the production capacity of the plant, a substantial subatmospheric pressure will be created at the suction side of the pump which is important for correct functioning of the metering apparatus 15, and a strong turbulence will be created in the conduits 12 and 13 and in the mixing tank 10 so that a good mixing of the water and the milk powder is obtained. The centrifugal pump 19 is now started, whereby recombined milk is pumped from the mixing tank through the discharge conduit 18, the preheating section 20 of the pasteurizer 21, and the conduit 22 with the static mixer 25 to the homogenizer 23, which is started together with the pump 19. Before the heated milk mixture in the conduit 22 reaches the homogenizer 23 and the static mixer 25 positioned upstream thereof, a metered amount of fat is currently supplied through the branched conduit 24. When passing the mixer 25 the fat, which is in a heated and fluent condition, is dispersed in the milk, and the milk product is homogenized in the homogenizer 23. The homogenized recombined milk is passed from the homogenizer 23 via the conduit 27 to the heating section 26 of the pasteurizer, in which the final pasteurization takes place. Thereafter the pasteurized milk is passed through the conduit 28 to the temperature control by-pass valve 29. This valve is adapted to return the recombined milk to the suction side of the centrifugal pump 19 via the by-pass conduit 32 and the one-way valve 33, if for some reason or another the milk has not obtained a predetermined pasteurization temperature, and the milk will then become recirculated through the pasteurizer and the homogenizer, till the desired temperature is obtained. Thereafter, the valve 29 is automatically switched to its other position, in which the pasteurized milk is passed from the conduit 28, and via the conduit 30 through the cooling section 31 of the pasteurizer 21 and

then via the conduit 34, the valve 35, and the product discharge conduit 37 to a storage tank or another storage site, not shown.

When liquid is discharged from the tank 10 through the discharge conduit 18, the liquid level in the tank 10 will sink. This is sensed by the level sensor 41 which will then automatically control the regulating valve 42 so as to currently replace the liquid discharged from the tank by supply of fresh water through the supply conduit 38. As the water supply takes place through the shower device 40, the water supply will serve to depress a possible foaming liability in the tank 10. Under the continuous operation of the plant the metering apparatus 15 is controlled in dependency of the water supply through the supply conduit 38 in such a manner that the recombined milk obtains the desired relation between water and dry matter (excluding fat), and the metering of fat through the branched conduit 24 is controlled in a similar manner.

By shifting the valve 35 the recombined milk flowing through the conduit 34 may be recirculated to the suction side of the pump 19 via the connecting conduit 36, if desired, and the metering of fat through the conduit 24 as well as the function of the metering apparatus 15 is then simultaneously stopped. Such shifting of the valve 35 may, for example, be made during the start up periods of the plant, and in case the supply of milk to the storage tank through the conduit 37 must temporarily be stopped for one reason or another.

The above described function of the plant during its continuous operation is preferably controlled by means of suitable electrical and pneumatic control systems. However, the controlling may in principle, be made manually. The control of the metering apparatus 15 may possibly be made by means of electrical signals from a refractometer which may, for example, be positioned along the product discharge conduit 37 of the plant for currently measuring the content of dry matter (excluding fat) in the finished milk product.

EXAMPLE.

In a plant of the type shown on the drawing the mixing tank 10 may have a total volume of 150 liters, and the level sensor 41 may be adapted to secure that an amount of liquid of 100 liters is present in the tank. An amount of about 1740 liters of tap water is supplied to the tank 10 per hour, and the maximum pumping capacity of the centrifugal pump 14 is 100,000 liters per hour so as to obtain a substantial degree of recirculation through the conduits 12 and 13 and a vigorous turbulence in the mixing tank 10. Metered portions of skimmed milk powder, each in an amount of about 235 g, is supplied to the return conduit 13 by means of the metering apparatus 15 at a frequence corresponding to about 850 portions per hour. Liquid is pumped from the mixing tank 10 to the pasteurizer by means of the centrifugal pump 19 at a flow rate corresponding to 1940 liters per hour. Fat heated to 40 - 50°C so as to be in a fluent condition is supplied to the milk product through the branched conduit 24 by means of a conventional fat metering pump. The fat is added in an amount of about 60 kg fat per hour. The homogenizer 23 operates at a temperature of about 75°C and at a pressure of about 200 atmospheres. The by-pass valve 29 is adapted to recirculate the milk through the by-pass conduit 32, if the milk is not heated to a temperature of at least about 72°C. The finished recombined milk is cooled to a temperature of about 5°C in the cooling section 31 of the pasteurizer 21, and the milk is passed to the storage tank at that temperature.

The mixing tank 10 has the form of a cylindrical container with a diameter of about 55 mm, and the axial spacing between the annular distributing tubes 16 and 17 is about 200 mm. The distributing tubes are made from tubes having a diameter of about 50 mm. The centrifugal pump 14 is of a type marketed by Pasilac A/S, Silkeborg, Denmark, under the designation "ZMS 3", and the metering apparatus 15 is of the type described in applicant's above Danish patent application No. 3162/80 and is arranged at the suction side of the centrifugal pump 14 at a position, where the pressure in the return line 13 is about 0.4 atmospheres.

For the purpose of comparison it may be mentioned that each mixing tank in a conventional milk recombining plant of the above type, in which the recombining process is alternately performed in one or another of two mixing tanks, must have a volume of about 2000 liters in order to obtain a production capacity of the same order as that of the plant according to the invention described in the present example.

In the above description the method and plant according to the invention has especially been disclosed in connection with recombining milk. However, it should be understood that the method and plant according to the invention could also be used for the production of milk products other than skimmed milk and full milk. Thus, for example, the method and plant according to the invention may be used for the production of ice cream, and the powdered material metered by means of the metering apparatus 15 may then be ice cream powder. It is also possible to use two or more metering apparatuses 15 in one and the same plant for metering pulverulent or particulate material. As an example, if it is desired to produce a cocoa drink the metering apparatuses may be used for metering milk powder, cocoa powder, and sugar, respectively. It should also be mentioned that the method and plant according to the invention could advantageously be used in connection with the mixing of a liquid and a pulverulent or particulate material in general, if problems arise due to foam formation when substantial volumes of air are introduced together with the pulverulent or particulate material.

Claims.

1. A method of making a liquid milk product, such as recombined milk, wherein metered amounts of a pulverulent or particulate material is currently added to a liquid which is circulated through a tubing system including a mixing tank (10), characterized in that said pulverulent or particulate material is sluiced into the tubing system in portions and substantially without entraining air.

2. A method according to claim 1, characterized in that fresh liquid is continuously supplied to and liquid milk product is simultaneously continuously discharged from the tubing system.

3. A method according to claim 2, characterized in that the supply of fresh liquid to the tubing system is controlled by means of a level control device (41) arranged within the mixing tank.

4. A method according to claim 2 or 3, characterized in that the liquid is circulated in the tubing system (12, 13) by means of a pump (14) having a capacity substantially exceeding the capacity of the tubing system.

5. A plant for use in carrying out the method according to any of the claims 1 to 4 and comprising a tubing system (12, 13) including a mixing tank (10), a pump (14) for circulating liquid in the tubing system, and a metering apparatus (15) for currently introducing metered amounts of pulverulent or particulate material into the tubing system, characterized in that the metering apparatus (15) is in the form of a sluicing device adapted to sluice metered amounts of said pulverulent or particulate material into the tubing system (12, 13) without entraining substantial amounts of air.

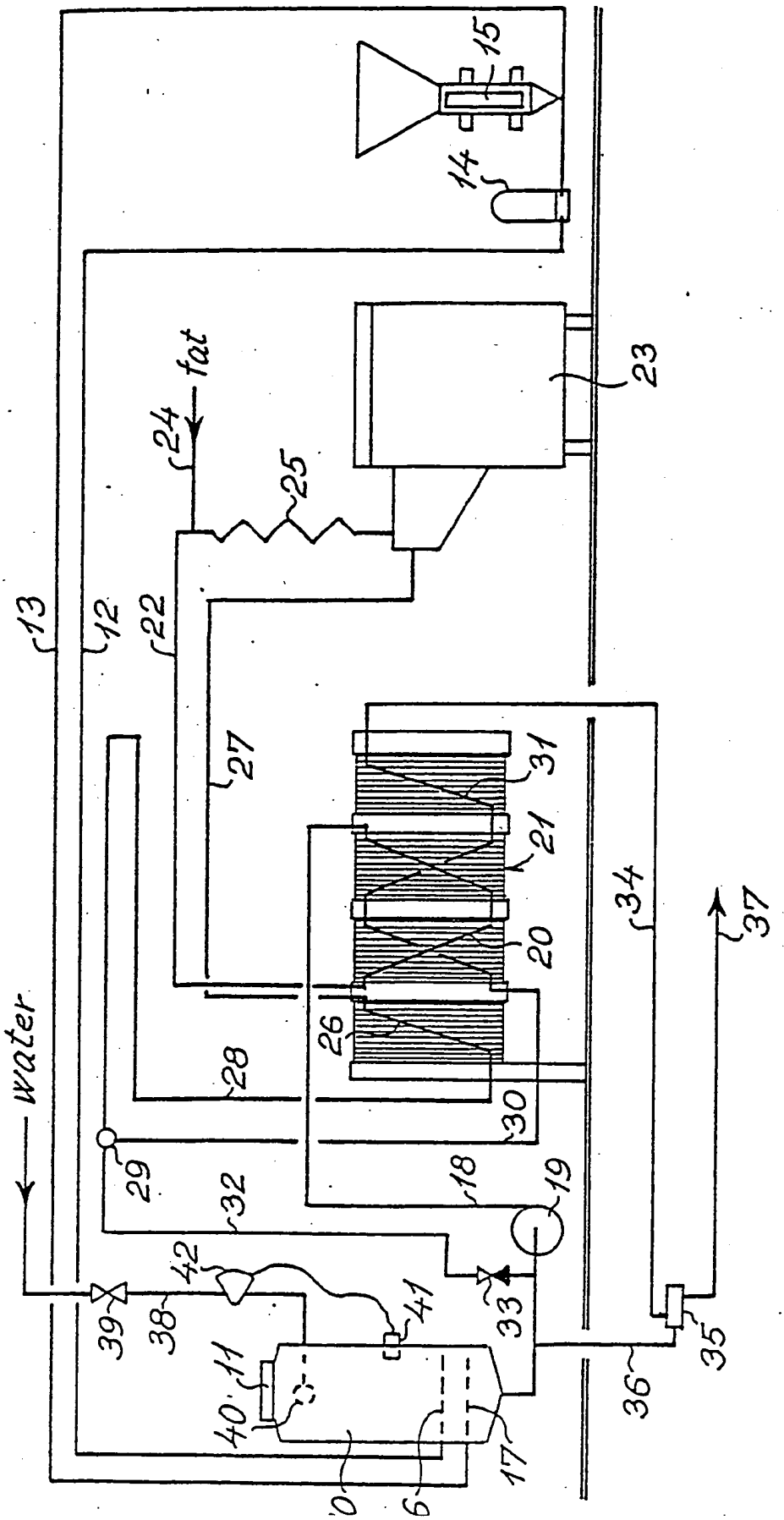
6. A plant according to claim 5, c h a r a c t e r i z e d in comprising a product discharge conduit (37) for continuously discharging finished product from the plant, and a supply tube (38) for fresh liquid and containing a control valve (39) which is controlled by a level control device (41) arranged within the mixing tank.

7. A plant according to claim 5 or 6, c h a r a c t e r i z e d in that the liquid circulating pump (14) has a capacity which substantially exceeds the capacity of the plant.

8. A plant according to any of the claims 5 to 7, c h a r a c t e r i z e d in that the metering apparatus (15) is connected to the tubing system (12, 13) on the inlet side (14) of the pump and includes a measuring chamber formed by a compressible tube or hose length, and compression means adapted to tightly compress the end portions of the tube length.

9. A plant according to any of the claims 6 to 8, c h a r a c t e r i z e d in that the outlet of the liquid supply tube (38) is arranged in the upper part of the mixing tank (10) and is in the form of a shower or spraying device (40).

10. A plant according to any of the claims 5 to 9, c h a r a c t e r i z e d in that the mixing tank (10) is communicating with the circulation pump (14) via a pair of axially spaced, annular tubes (16, 17), which is arranged in the lower end of the tank, each annular tube being provided with a pattern of openings directed towards each other.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INTERNATIONAL SEARCH REPORT

International Application No PCT/DK81/00072

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC 3

A 23 C 9/00, B 01 F 3/12

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC 2	A 23 C 9/00,9/10, B 01 F 3/12,13/00,13/04,13/10, B 01 J/1/00, B 01 J 4/00
National Cl	12f:4; 12g:1/01
US Cl	426:587, 588

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [5]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	NO, B, 27 759 published 1917, March 19, J. Jörgensen	
A	FR, A, 2 093 908 published 1972, February 4, M. Blanchaud	
A	DE, A, 2 316 403 published 1974, October 10, C. Jebens	
A	GB, A, 1 295 872 published 1969, November 8, I.A. Bratland	

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
1981-11-11	1981 -11- 16
International Searching Authority [1]	Signature of Authorized Officer [20]
	Agneta Ruggard